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ABSTRACT

This report is based on a survey of the National Science Foundation's Industrial Panel on Science and Technology. The panel comes from essentially all major types of industry involved in research and development (R&D) and covers a wide range of firms and cooperations. The findings of the survey show that almost one-half of those who responded to the survey reported that, since 1970, their firms have increased the proportion of Ph.D.s among those hired for R&D activities. The most often cited reasons for this change in hiring practices were: (1) industrial technology has become more complex, and (2) more science and engineering Ph.D.s have been available for work in industry. The findings also show that about 30% of the respondents expect their firms to increase the proportion of R&D employees who have doctorates while only 3% anticipated a drop. Tabulated data present distribution of responses from directors of industrial research and development on past and anticipated proportions of employees who have doctorates. (Author/HM)

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nsf SCIENCE RESOURCES STUDIES HIGHLIGHTS

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Utilization of Science and Engineering Doctorates in Industrial Research and Development

This report is based on a survey of the National Science Foundation's Industrial Panel on Science and Technology. The Panel comes from essentially all major types of industry involved in research and development and covers a wide range of firms and corporations, many of which are among the largest private business enterprises in the United States. The Panel, however, does not represent a statistically valid sample of all industrial employers of scientists and engineers engaged in research and development. Therefore, the survey responses should be interpreted as being only broadly representative of the opinions of such employers.

Assessment Highlights

Why has industry increased hires of Ph.D.'s while total industrial R&D employment has been stable?

- Almost one-half of those who responded to the survey reported that since 1970 their firms have increased the proportion of doctorates among their hires for R&D activities. The most often cited reasons for this change in hiring practices were (1) industrial technology has become more complex, and (2) more science and engineering (S/E) Ph.D.'s have been available for work in industry. Other factors cited include the small difference in salaries between Ph.D.'s and baccalaureates and the greater willingness of new doctorates to work in applied research and development compared to doctorates graduating several years ago.

What is the outlook for Ph.D.'s seeking employment in the future in industrial research and development?

- About 30 percent of the respondents expect their firms to increase the proportion of R&D hires who have doctorates, while only 3 percent anticipate a drop.

Introduction

In the last few years doctorates have accounted for a larger share of scientists and engineers employed in industrial research and development. From 1973 to 1975 industry added almost 6,000 Ph.D.'s to its R&D payroll[1] while total industrial R&D employment remained stable. It is important to determine what the present situation is and whether the trend of the last few years is likely to continue into the future. The importance of this is supported by the likelihood that industry has the greatest potential of all sectors to expand employment of Ph.D.'s during the next few years when the academic labor market is expected to be very tight. Accordingly, NSF asked 98 directors of industrial R&D activities if in recent years their firms had increased the proportion of doctorates among their hires for research and development and, if so, to explain why this had taken place. Respondents to the survey, all members of the NSF Industrial Panel on Science and Technology, were also asked to report whether they expect to increase this proportion in the future and, if so, why. Finally, the R&D directors were asked to comment on whether underutilization of Ph.D.'s is a problem in their firms. This was done to assess whether industry has been able to absorb greater numbers of doctorates while still utilizing their specialized training.

Sixty-six panel members responded to the survey letter. These included representatives of many of the largest U.S. corporations as well as a group of medium and smaller sized companies. The table at the end of the discussion contains a tabulation of replies to specific questions while the summary below briefly reports some of the explanations given by the respondents for their firms' hiring practices as well as their perceptions regarding underutilization. Several quotations from the replies of the Panel Members are given to illustrate more directly the nature of the responses.

Two factors should be considered in interpreting the survey responses. First, as stated earlier, the membership of the panel is not a random sample of all industrial employers of S/E doctorates. Second, the managers were asked to report only on employment in R&D activities. Those S/E doctorates engaged in other types of industrial work, such as production and inspection, are outside the scope of the survey.

[1] Essentially all of this increase was accounted for by those engaged in applied research or development or in R&D management.

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Prepared in the Supply and Education Analysis Group, Division of Science Resources Studies.

Findings

INCREASED HIRING OF PH.D.'S

Slightly less than one-half of the respondents reported that since 1970 their firms have increased the proportion of doctorates among their hires for research and development. The reason most often given for employing proportionately more Ph.D.'s was that the hiring company has become more involved in complex technological activities which require the advanced skills gained in graduate training. This complexity came about either through a change in the company's areas of interest or through the continued development of the technology in which the company was already involved in 1970.

About one-fifth of the respondents stated that the increased availability of Ph.D.'s since 1970 has prompted an upgrading of the academic credentials of those hired for research and development.

Some other reasons given were that in recent years fewer able baccalaureate- and master's-degree candidates have applied for employment; Ph.D.'s have adopted more realistic attitudes toward work in industry and applied research and development; Ph.D.'s now cost little more than the lesser trained; and the quality of Ph.D.'s has improved.

Firms reporting higher proportions of hires with Ph.D.'s represented a very broad range of industries including pharmaceuticals, chemicals, electronics, primary metal processing, heavy manufacturing, and textiles.

Representatives of other firms in several of these same industries, as well as the petroleum production and refining industry, reported no increases in their proportions of Ph.D. hires.

A ranking of the responding firms by total number of employees (not just those engaged in research and development) revealed that smaller and larger firms were equally likely to have increased the proportion of hires with Ph.D.'s since 1970.

Below are a few direct quotations from the respondents regarding their hiring of Ph.D.'s. These were chosen to represent the major types of comments in this area.

Technical competence, comparative cost, and versatility of doctorates

"Yes, we are hiring a substantially higher proportion of Ph.D. scientists than we were 5-10 years ago. The three main reasons for this increase are:

Technical competence—We have had difficulty finding B.A. and M.A. candidates qualified to carry out independent R&D activities in our chemical laboratories. In fact, most of our technicians now almost have B.A. equivalency.

Cost—Salary comprises only a small part (roughly 30 percent) of the cost of keeping a man in an industrial laboratory. The salary difference between a B.A. and Ph.D. chemist is only $5-10,000 per year. This difference is only 10-15 percent of the total cost. So why not get a Cadillac instead of a Chevy - providing you can effectively utilize a Cadillac.

Greater versatility—We often find B.A. chemists with specific areas of expertise who would be as good or better than any Ph.D.'s. However, our programs don't last forever. Sooner or later, they would have to work in an area unfamiliar to them. Furthermore, our Ph.D. chemists have a much greater potential in R&D management where their advance training enables them to cope with a large number of different chemical enterprises."

Changed attitudes of doctorates

"Prior to the recent recession affecting technical personnel, Ph.D.'s were not oriented toward applied or practical research. They were primarily oriented toward basic or fundamental research as sponsored by NASA and other governmental agencies. The problem of nonindustrial orientation of Ph.D.'s was compounded because this type of work was also funded at the universities where a generation of professors exist, almost none of whom have practical working experience and who have spent their entire life in and around universities with no appreciation of industrial research and development. Unfortunately, they trained students in their image and it was not unusual for these graduates to feel that anything that had a practical solution or a realistic time frame was not research. The recent recession in technical personnel has changed some of these misconceptions, and Ph.D.'s who have had an unhappy five or six years experience are now much more realistic in their outlook and objectives."

Increased sophistication of R&D activities

". . . the nature of our projects has changed to include more sophisticated work which in many cases requires specific knowledge that would be expected from Ph.D. candidates. . . . We have in this period received a large number of unsolicited resumes from Ph.D.'s who have, for various reasons, been on the market. Interestingly, the requested salaries of these candidates were not substantially different from salaries required to attract technical people with B.S. and M.S. degrees."

Shortage of qualified baccalaureate candidates for employment

"Since 1970 Ph.D.'s have not represented a substantially larger proportion of our new R&D employees. They have represented a relatively (not 'substantially') greater proportion of new hires primarily because the high quality personnel we seek were not as available at the B.S. level. We assumed that this was because a higher proportion of the very competent B.S. people were going on to graduate work."

Shortages in some fields

"We have not changed in any substantial way since 1970 the proportion of Ph.D.'s we hire. For research we hired only Ph.D.'s in 1970 and still do. In development, we hire a mixture of Ph.D.'s, M.S. and B.S., but the mix hasn't changed much. We would hire more Ph.D.'s but are supply-limited in the disciplines of greatest interest (electrical engineering and computer science/engineering)."

Economic stringencies prevent increased hiring of doctorates

"The proportion of our new R&D employees with doctorate degrees has not changed significantly since 1970. Likewise, the nature of our R&D activities has not changed to a large extent. The availability of Ph.D.'s has not affected us, but the state of the economy has kept us from adding any more Ph.D.'s to our staff."

FUTURE HIRING PLANS

Over 30 percent of the responding R&D directors anticipated that their firms would raise the proportions of R&D hires with Ph.D.'s above current levels in the next 5 to 10 years. Only 3 percent of the respondents expect a reduction in such hires. Firms planning to employ proportionately more Ph.D.'s in the future were about equally divided between those that have also hired more from 1970 till now and those that have not. Reasons given for such future hiring plans were similar to the explanations given above for hiring more Ph.D.'s in the past 7 years. Again firm size did not affect responses. Below are three quotations from Panel members which represent the broad range of responses.

No change in proportion of hires with Ph.D.'s anticipated

"I do not expect the proportion of our company's R&D hires of Ph.D.'s to change within the next five years. I cannot really say much on our company's policy beyond five years. I do not think that the salary differentiation between Ph.D.'s and lesser trained staff is or will be a factor in our choice of R&D staff. After a few years, differences in salaries are more affected by the employee's achievements than his qualifications. . . . "

Shift toward development activities may reduce need for Ph.D.'s

"Within the next five to ten years I do not expect the proportion of new R&D employees with Ph.D.'s to increase because the areas in which we are expanding the staff are more development oriented and would therefore require fewer Ph.D.'s. There is, therfore, a chance that the proportion of new employees with Ph.D.'s will decrease during this time period. If starting salary differentials were smaller between Ph.D.'s and lesser trained employees, this fact would not be important in changing the proportion."

Upgrading of research staff will require proportionately more hiring of Ph.D.'s

"Our long range planning calls for a marked expansion of R&D activities which will necesitate the hiring of more Ph.D.'s as well as supporting staff. Smaller starting salary differentials will be a factor in determining the proportion of Ph.D.'s to lesser-trained staff. Another factor, however, which will contribute to this trend is the fact that we intend to upgrade the quality of our research staff. In our opinion, the best approach to achieve this goal is to hire more highly trained individuals."

UNDERUTILIZATION

Only a few respondents indicated that underutilization of doctorates, whether from the perspective of the employer or employee, is a problem in their companies. The comments of some of those so replying are given below. Direct quotations are appropriately indicated. Other comments are paraphrased. Because those few Panel members who indicated that underutilization is a problem gave a wide variety of explanations, excerpts from their responses, either in the original language or paraphrased, better convey the nature of their comments than would a summarization. It should be remembered that comments such as these came from only a small number of the respondents.

Too few support staff can lead to underutilization of doctorates

Sometimes the company hires too many Ph.D.'s and too few technicians thus forcing the former to assume some duties usually performed by support staff.

Some Ph.D.'s expect special consideration

Some Ph.D.'s believe their training entitles them to more privileges and attention than are accorded to other staff. If they do not receive these special considerations, they complain of being underutilized.

Some Ph.D.'s accept positions for which they are poorly suited

". . . some highly trained people are not comfortable working outside their particular area of interest, and yet seem willing to accept a less than appropriate assignment as opposed to actively seeking a job change."

Emphasis in academic training on research poorly prepares Ph.D.'s for industry

"Without question many Ph.D.'s are underutilized (or overeducated) . . . . The primary cause in the long run has been the extreme emphasis in academic science education on research as the primary purpose for obtaining a science degree and the Ph.D. as the 'union card' for doing research. The situation in engineering is very different and probably fits the needs of industry better."

There is too little intellectually challenging work for doctorates

"We agree that Ph.D.'s engaged in industrial R&D are somewhat underutilized and anticipate that the situation will worsen in the future . . . . we attribute this to . . . the fact that organizations like ours have less intellectually challenging work than our core of Ph.D.'s would like."

Outlook

Will industry continue to increase the proportion of its R&D staff who have doctorates? It probably will, because the two factors most responsible for the increased role of the Ph.D. up till now are likely to persist for the next 5 to 10 years. These two factors are the growing complexity of industrial technology and the fairly ready availability of new Ph.D.'s. An ample supply of doctorate scientists and engineers in most fields should be available to industry.[2] Not all companies engaged in research and development, however, seem prepared to accept larger proportions of Ph.D.'s among their hires, either out of a conviction that lesser trained and cheaper staff can perform as well in some jobs or because of a belief that Ph.D.'s are not well suited by virtue of their training to work in a profit-oriented environment. On the other hand, if there is a further decline in the salary differential earned by Ph.D.'s in relation to baccalaureate and master's graduates, probably some of those firms not now planning to accelerate Ph.D. hiring will do so.

[2] National Science Foundation, *Projections of Science and Engineering Doctorate Supply and Utilization, 1980 and 1985* (NSF 75-301) (Washington, D.C. 20402: Supt. of Documents, U.S. Government Printing Office, 1975). New, soon to be published, NSF projections extending till 1987 also indicate ample supply in most fields.

Greater numbers of doctorates on R&D staffs may lead to their underutilization in those companies which do not also employ adequate numbers of support staff. This, however, should be a problem of management in individual firms rather than an industry-wide difficulty. The expected growing complexity of technology should fully engage the skills of most Ph.D.'s employed in industrial research and development.

Distribution of Responses from Directors of Industrial Research and Development on Past and Anticipated Proportions of Hires Who Have Doctorates

Hires in 1970-1977		
R&D directors reporting an increase in the proportion of hires who have doctorates	R&D directors reporting no increase in the proportion of hires who have doctorates	Total
30 (47%)	34 (53%)	[1]64 (100%)

Anticipated Hires in 1982-1987			
R&D directors anticipating an increase in the proportion of hires who have doctorates	R&D directors anticipating no change in the proportion of hires who have doctorates	R&D directors anticipating a decrease in the proportion of hires who have doctorates	Total
19 (30%)	42 (67%)	2 (3%)	[2]63 (100%)

[1] Two nonresponses.
[2] Three nonresponses

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